

Gulliver (George), F.R.S. Notes of Researches in Anatomy, Physiology, Pathology, and Botany. 8vo. *Canterbury* 1880.

The Author.

Liversidge (A.) Disease in the Sugar Cane, Queensland. 12mo. *Sydney*. And a Volume containing twenty-one Pamphlets by Professor Liversidge.

The Author.

Spratt (Rear-Admiral T.), F.R.S. A Suggestion for the Improvement of the Entrance to the Mersey. 8vo. *London* 1880.

The Author.

April 8, 1880.

THE PRESIDENT, followed by Mr. WARREN DE LA RUE,
in the Chair.

The Presents received were laid on the table, and thanks ordered for them.

The following Papers were read :—

- I. "Note on Thermal Transpiration." By O. REYNOLDS, F.R.S., Professor of Engineering in Owens College, Manchester. In a Letter to Professor STOKES, Sec. R.S. Communicated by Professor G. G. STOKES. Received October 25, 1879.

Owens College, 23rd October, 1879.

DEAR SIR,

I have just received a copy of a paper by Professor Maxwell from the "Philosophical Transactions of the Royal Society," read April 11, 1878, "On the Stresses in Rarefied Gases." To this paper I find that there is an appendix added in May, 1879, in the course of which he refers to my investigation in the following words :—

"This phenomenon, to which Professor Reynolds has given the name of Thermal Transpiration, was discovered entirely by him. . . . It was not till after I had read Professor Reynolds's paper that I began to reconsider the surface conditions of a gas, so that what I have done is simply to extend to the surface phenomena the method which I think most suitable for treating the interior of the gas. I think that this method is, in some respects, better than that adopted by Professor Reynolds, while I admit that his method is sufficient to establish the existence of the phenomena, though not to afford an estimate of their amount."

As the abstract of my paper does not contain a sufficient account of

what is in the paper to enable a reader to form a fair judgment of the relative merits of the two methods, I venture to request those interested in the subject to withhold their opinion until they have an opportunity of reading my paper. In the meantime I can only express my opinion that Professor Maxwell is mistaken in supposing that the results which are obtained from his method are more definite than those to be obtained by mine.

His method only applies to a particular case, and the equation which he has given is identical with that which I have given for this particular case.

The particular case treated by Professor Maxwell is the extreme limit—when the tube is large as compared with the distances between the molecules; he does not deal at all with the other limit—when the distances between the molecules are large as compared with the tube. Whereas I have given definite values for the coefficients in both limits, as well as indicating the manner in which the coefficients vary between these limits.

It so happens that the case in which the tube is large as compared with the molecular distances is one in which the results are too small to be experimentally appreciable, and hence Professor Maxwell's method does not explain any of the actual experimental results.

In order to explain the experimental results obtained with porous plates, Professor Maxwell has reverted to Graham's assumption that fine plates act as apertures in thin plates, while the coarse plates act like a tube, an assumption which my experiments show conclusively to be unnecessary and erroneous, the only sensible action in either case being that of tubes, and hence the phenomena of porous plates is that of transpiration and not effusion.

I remain

Yours truly,

OSBORNE REYNOLDS.

PROFESSOR STOKES, F.R.S.,

Secretary to the Royal Society.

Note by the Communicator.

In communicating the above letter to the Royal Society, in accordance with Professor Reynolds's wishes, I would beg permission to add a few remarks.

Professor Maxwell did not profess to treat more than the two extreme cases, constituting what Graham called respectively transpiration and diffusion. His statistical method applies, indeed, only to the first of these limits; but he has distinctly considered the second, following a suggestion of Sir William Thomson's. It is true that at the first limit, as Professor Reynolds remarks, the results are too

small to be experimentally appreciable; but this was distinctly stated by Professor Maxwell himself, at the foot of p. 256.

As to the second limit, I must remark, in the first place, that I cannot find that Graham made any assumption that porous plates act as apertures in thin plates. The result that the time of passage varies, *ceteris paribus*, as the square root of the density in the case of fine porous plates, was obtained by pure experiment; and though he could not fail to notice the accordance of this result with that of the mere hydrodynamical passage through a small aperture, he has carefully distinguished between the two. Nor can I agree with Professor Reynolds in regarding the explanation given by Professors Thomson and Maxwell of the phenomenon of thermal transpiration or thermal effusion, whichever it be called, afforded by assimilating a fine porous plate to a thin plate pierced by apertures of ideal fineness as erroneous, even though it should be shown that such assimilation is unnecessary. Professor Maxwell did not profess to treat in his paper the intermediate cases between the two extreme limits.

Perhaps I should mention, that the foot-note at p. 281 in Professor Maxwell's paper was added as the paper passed through the press. I recollect noticing the thing as, in my capacity of Secretary, I looked over the paper before sending it to be printed off, and considering whether I should affix a date. As, however, it seemed to me to contain merely an explanation of an expression in the text, and as Maxwell, who had carefully added the dates of fresh matter in other parts, did not seem to have thought it necessary to do so in this case, I left it as it was. In a letter I received from him at the time, he informed me that he felt very ill, and was hardly fit even to go through his own paper; though a subsequent letter, in which he entered into some scientific matters, was written in his usual cheerful style. No one had, I believe, at that time any notion of the very serious nature of his illness.

March 13, 1880.

G. G. STOKES.

II. "On the Sensitive State of Vacuum Discharges. Part II."

By WILLIAM SPOTTISWOODE, D.C.L., LL.D., Pres. R.S., and J. FLETCHER MOULTON, late Fellow of Christ's College, Cambridge. Received March 11, 1880.

(Abstract.)

This paper forms a sequel to that published under the same title in the "Phil. Trans.," 1879, p. 165. It describes a continuation of the research into the nature and laws of the disruptive discharge, or elec-